APPENDIX L. Summary Report: Compilation of Total Visual Survey Effort and Sightings for Marine Species Monitoring in Hawaii Range Complex, 2007-2011

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1. INTRODUCTION

In order to train with mid-frequency active sonar (MFAS) and underwater detonations, the Navy obtains incidental take permits and Letters of Authorization from the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act and Endangered Species Act. The Hawaii Range Complex (HRC) Monitoring Plan was developed with NMFS to comply with the requirements under the permit. The monitoring plan and reporting are intended to provide science-based answers to questions regarding whether or not marine mammals are exposed and reacting to Navy exercise activities.

In order to initiate the program of integrating the historical sum of these Navy-sponsored marine species monitoring efforts in the HRC, this summary report describes the efforts to collect, compile, standardize, and migrate existing visually-based field survey data into a fully geo-referenced database in a geographic information system (GIS).

The goal of this initial phase is to process and compile available data from visual surveys performed by both contractor-led efforts as well as Navy in-house ones, such that:

1. A GIS-based summation of all survey tracks could be visualized

2. A geo-referenced database of sightings can be queried to visualize sightings by species or survey variables such as observer platform, sea state, or season

Future goals of later phases include continuing to expand the geo-referenced database with respect to incorporating more past and future survey data, expanding the completing the internal field structure of the geo-referenced database with which more detailed queries will be possible, to compare visual detections with results from past and ongoing passive acoustic monitoring efforts, and to make conclusions as to the effectiveness and interactions of the various variables of visually-based field survey effort in the HRC including: location, platform, field protocol, season, and observational technique (visual or acoustic).

2. METHODS

All visual surveys previously conducted for Commander, U.S. Pacific Fleet's marine species monitoring program were considered for compilation and analysis. Surveys included both those conducted by contractors as well as those conducted by Navy biologists, as well those using both aerial and vessel-based observational methods on both civilian and Navy assets. Not included were surveys and survey legs that did not include collection of a GPS track, or that did not collect positions of sightings, such as nearshore diver-based underwater turtle surveys.

Data collected for each latitude and longitude position of the on-effort survey include date, time, survey description, aerial or vessel platform, seastate, glare, and cloud cover. Data for sightings include species, number of individuals, behavior, and sighting information such as perpendicular angle for aerial surveys, and bearing for vessel surveys. Total distance to the sighting was computed for aerial surveys using altitude and angle, and the same computed for vessel surveys using either direct estimation or sighting device reticle data (e.g., hand-held binoculars or big-eye binoculars). All of the above data fields were standardized to metric units when applicable; a large proportion data deliverables from surveys were not given wholly in metric (e.g., altitude is

generally referenced in feet), in which case these were converted in the standardization process such that all data in the resulting georeferenced database were expressed in metric units. Also all data variable types were explicitly specified as text, number, date, or time. Because the data deliverables from the various surveys were sourced from different data collection applications (e.g., WinCruz, Garmin GPS, Excel-based GPS log, manual data entry), all surveys required some translation of the data types, as well as computation for sighting distance. Two examples are illustrated below:

Wincruz Time transformation: For the variable "time," WinCruz raw output tables were extracted from a Microsoft Access database, then the seven or eight character long text string (e.g., "41848") in the field representing time was combined with an associated text string from a separate field representing 12-hour time (e.g., "AM" or "PM") then transformed into 24-hour-formatted time structured as a date field for Microsoft Excel (e.g., 0.679723 = "16:18:48").

Latitude/longitude transformations: Similar transformations were made for latitude and longitude positions such that the numerical values were extracted from text fields, as formatted in various electronic deliverables. For example some inputs were three separate text fields for each position axis, such as " W159 ", "48", and "32" for longitude in degrees, minutes, and seconds, or a single (non-numeric) text field that incorporates both latitude and longitude, such as "N21.35139 W157.94337". Other deliverables were similarly presented in degrees and decimal minutes. All variants were translated into a decimal and entirely numeric representation that incorporates "West" in the case of longitude, e.g., -159.80889.

After standardization, all tracks and sighting data were entered into a single geo-referenced database project using ArcMap 9.3.1 and based within the U.S Navy Environmental Information Management System (EIMS). ArcMap enables queries for specified survey and sighting types, as well as the graphical display on a map of the total sum of sighting and survey track results. Progressive updates or corrections to the source data files immediately results in the ability to generate updated results graphics.

2.1 Included surveys

In total, there were eighteen surveys included in the compilation and analysis, and are listed below with contractor name and contract number:

1. 2007 November 11-17 USWEX aerial survey (MMRC, Contract #N62742-07-P-1914)
2. 2007 November 11-17 USWEX 2007 vessel survey (Cetos, Contract #N62742-07-P-1915)
3. 2008 May 26-27 & June 2-4 USWEX aerial survey (MMRC, Contract #N62742-08-P-1933)
4. 2008 July 12-17 RIMPAC vessel survey 1934 (MMRC, Contract #N62742-08-P-1934)
5. 2008 July 13-17 RIMPAC aerial survey 1935 (MMRC, Contract #N62742-08-P-1935)
6. 2008 August 18-21 SCC aerial survey (MMRC, Contact #N62742-08-P-1942)
7. 2009 February 15-19 SCC aerial survey (SES & MMRC, Contract #N62742-09-P-1956)
8. 2009 June 17-25 ULT and UNDET aerial monitoring (MMRC, Contract #28H-1087365)
9. 2010 February 16-21 SCC aerial survey (MMRC, Contract #N62742-08-P-1803)
10. 2010 June 26-28 Ka'ula islet survey (NAVFAC Pacific)
11. 2010 July 10, 17 RIMPAC SINKEX monitoring, PMRF (NAVFAC Pacific)

12. 2010 August 15-17 RIMPAC vessel survey (HDR, Contract #N62470-10-D-3011 CTO KB01)
13. 2010 November Koa Kai, lookout effectiveness study (NAVFAC Pacific)
14. 2010 November Koa Kai vessel survey (HDR, Contract #N62470-10-D-3011 CTO KB05)
15. 2010 November Koa Kai aerial shoreline survey (HDR, Contract #N62470-10-D-3011 CTO KB05)
16. 2011 February SCC & USWEX lookout effectiveness study (CPF and NAVFAC Pacific)
17. 2011 April 12, May 10, 16 Pearl Harbor entrance channel sea turtle vessel and diver survey (NAVFAC Pacific)
18. 2011 June 30 Ka'ula islet survey (NAVFAC Pacific)

2.1.1 Subset of surveys included for humpback whale analysis

Due to the seasonal presence of humpback whales in the HRC, only surveys spanning from November through April were included for the humpback whale graphic in Fig. 7. Therefore only these surveys tracks are displayed in the graphic of total survey effort below. The surveys included were:

1. 2007 November 11-17 USWEX aerial survey (MMRC, Contract #N62742-07-P-1914)
2. 2007 November 11-17 USWEX 2007 vessel survey (Cetos, Contract #N62742-07-P-1915)
3. 2009 February 15-19 SCC aerial survey (SES & MMRC, Contract #N62742-09-P-1956)
4. 2010 February 16-21 SCC aerial survey (MMRC, Contract #N62742-08-P-1803)
5. 2010 November Koa Kai, lookout effectiveness study (in-house NFP)
6. 2010 November Koa Kai vessel survey (HDR, Contract #N62470-10-D-3011 CTO KB05)
7. 2010 November Koa Kai aerial shoreline survey (HDR, Contract #N62470-10-D-3011 CTO KB05)
8. 2011 February SCC & USWEX lookout effectiveness study (in-house NFP)

2.2 Surveys not included

2.2.1 Surveys with potential to qualify but not included

Other possibly qualifying surveys that were not included, and the reasons these were not included are:

1. 2005 February 17-24 vessel survey (Cetos/Geo-Marine, Contract #2057sa05-F): no electronic deliverables of survey track available.
2. 2006 July 16,17,20,24-6 RIMPAC aerial survey (Kaulakahi & Alenuihaha channels) (MMRC, Contract #N62742-06-P-1887): no electronic deliverables of survey track available.
3. 2007 January 7-February 2 Island of Hawaii vessel survey (Cetos, Contract #N62742s-07-P-1895): no electronic deliverables of survey track available.
4. 2009 August 26-30 SCC aerial survey (MMRC & SES, Contract #N62742-09-P-1966): no electronic deliverables of survey track available.

5. 2011 February 15-20 Ka'ula islet survey (NAVFAC Pacific): data deliverables were not available to be compiled because these have yet to be reconciled between the two vessels utilized during the field effort, one being a contractor-operated vessel, and the other directed by Navy biologists.

If it is intended in FY12 to attempt the resolution of the acquisition of electronic deliverables necessary for incorporation of the items above into the data compilation effort.

See also item #3 in Section 4.2 for surveys not included within the Commander, U.S. Pacific Fleet marine species monitoring program, but which may also qualify for inclusion.

2.2.2 Qualifying survey not included

One qualifying survey was not included at the time of the writing of this report, and will be incorporated into the analysis during FY12:

1. 2010 July 15, 2011 April 26-27 August 10-11 UNDET monitoring, Puuloa range (NAVFAC PACIFIC): The underwater detonation (UNDET) monitoring surveys were graded as lower priority than the other eighteen surveys due to both limited geographic expanse and number of sightings; this item is expected to be incorporated in the next phase of data compilation in FY12.

2.2.3 Partial list of surveys not qualifying

The following surveys were not included in the survey because these did not fulfill the criteria required for compilation into the analysis:

1. 2004-2011 Navy biologist diver underwater surveys for sea turtles (NFESC): no GPS positions of track or sightings
2. 2009 June 18-19 UNDET monitoring (NAVFAC PACIFIC): no GPS positions of track or sightings
3. 2009 July 21-22 Ka'ula islet survey (NAVFAC PACIFIC): no GPS positions of track or sightings

3. RESULTS

3.1 Summary of surveys and sightings

For the analyzed surveys, the following graphics display total survey track effort, and total sightings by species. Species not included due to a lack of sightings occurring within the included surveys are: hawksbill sea turtle (*Eretmochelys imbricata*), sperm whale (*Physeter macrocephalus*), melon-headed whale (*Peponocephala electra*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*), Longman's beaked whale (*Indopacetus pacificus*), and killer whale (*Orcinus orca*).

Sighting events are denoted by red circles, and may represent one or multiple animals. Special use airspace warning area boundaries are delineated in cyan, and the boundaries of the underwater ranges at PMRF in light green.

The survey tracks for the lookout effectiveness studies conducted on Navy vessels during exercises (survey #13 and #16 in section 2.1) are represented as lines drawn between ship positions filtered to approximately once every several hours so that the general areas traversed by the vessels are well represented, but not the exact track—therefore in some cases sightings from these surveys may appear offset from the indicated track line.

The survey tracks and sightings for some surveys may not be adequately represented at the large scale of the HRC, in particular the diver-RHIB sea turtle surveys conducted outside the mouth of Pearl Harbor (survey #17 in section 2.1). Species where sightings occur very closely together are also similarly not accurately represented on the large HRC-scale map, in particular sea turtles and humpback whales (Figs. 5, 7), due to overlap of sighting markers.

Figures 1-4 show all sightings of marine mammals, with the exception of humpback whales for the sake of clarity because of the high frequency of sighting of this species. Figures 5-20 illustrate sightings by species or species groups.

3.2 Figures

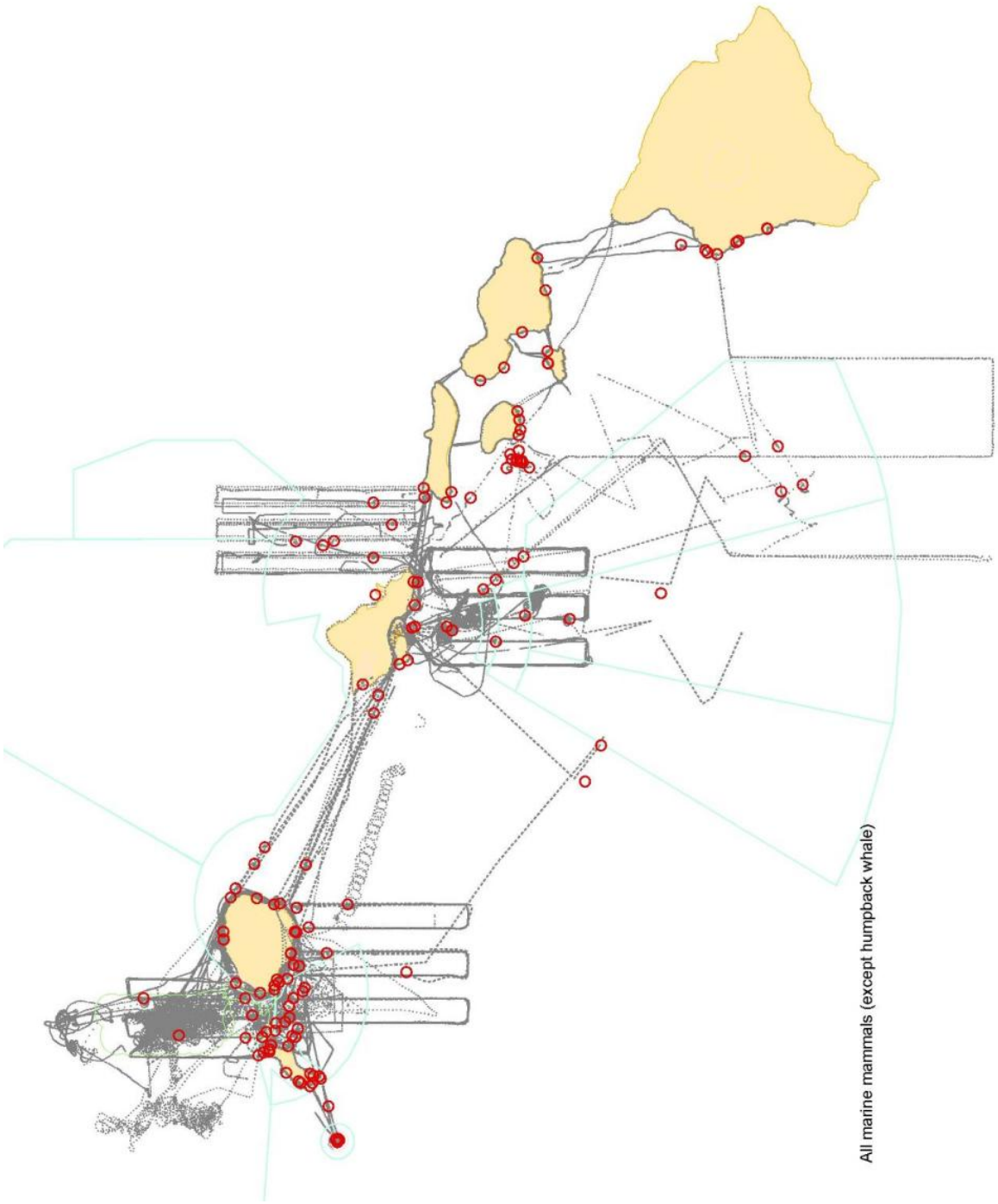

Figure 1. All survey tracks and all marine mammal sightings (except humpback whale)

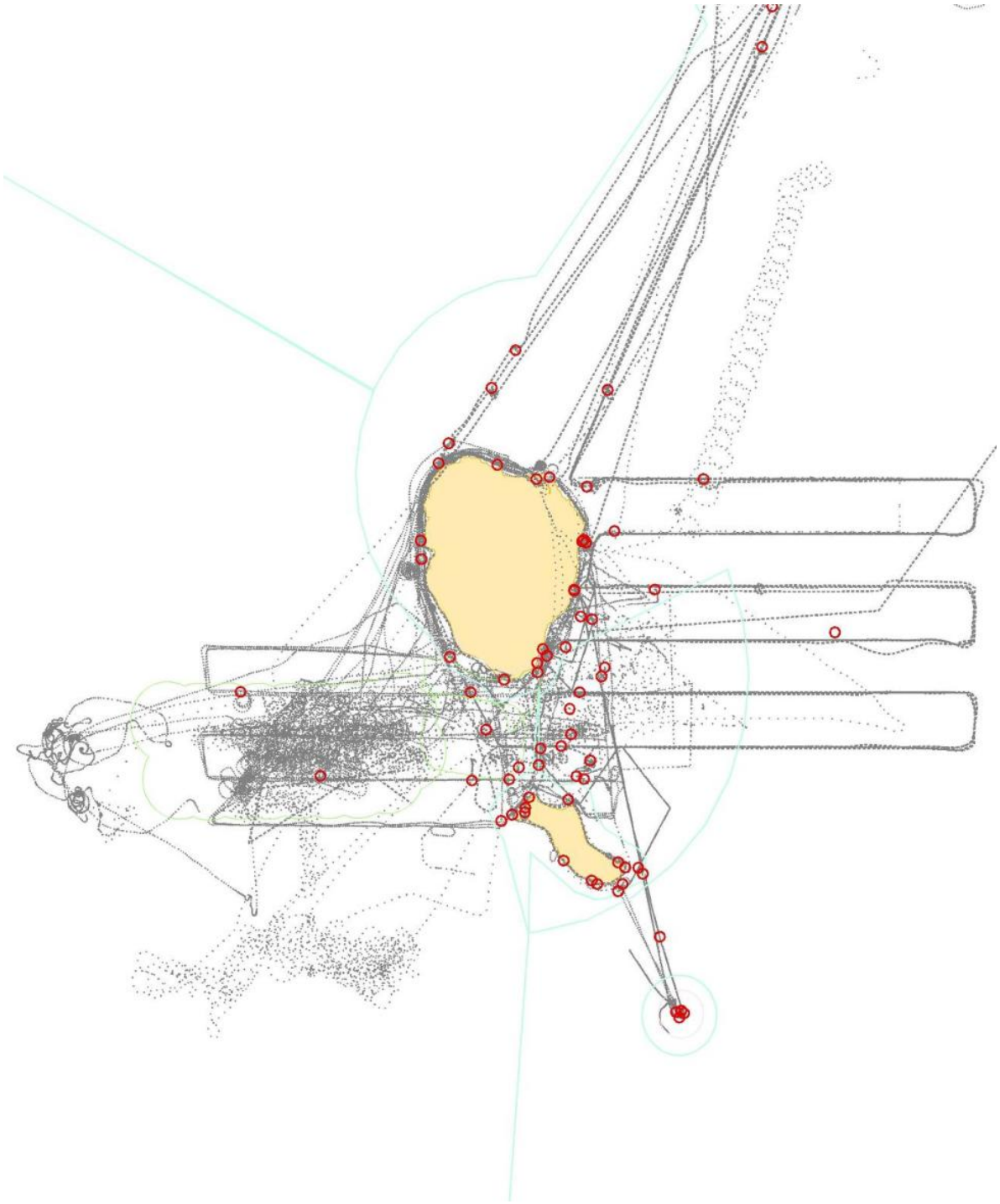

Figure 2. : Detail Kauai/Niihau: All survey tracks and all marine mammal sightings (except humpback whale)

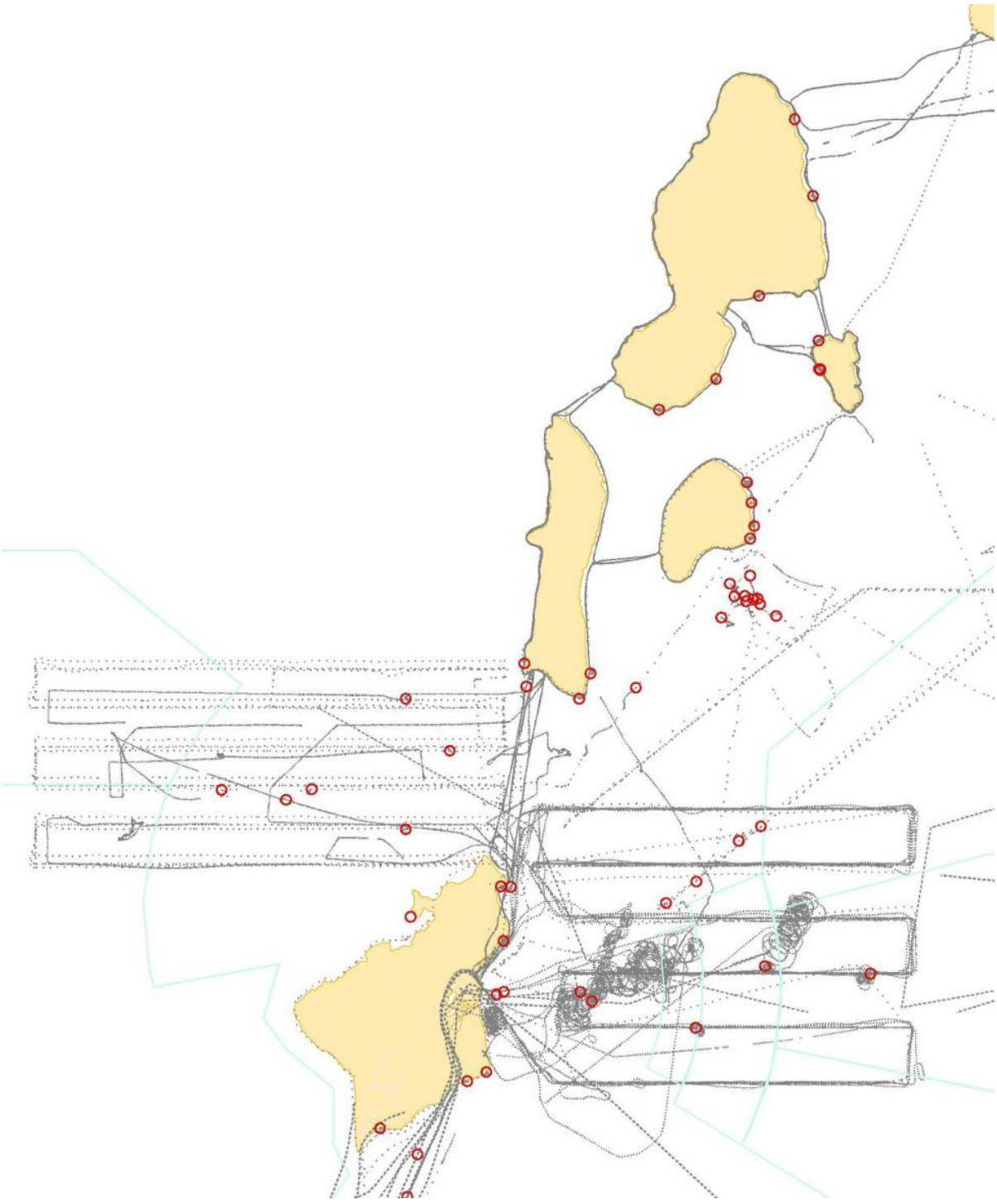

Figure 3. Detail Oahu/Four-island region: All survey tracks and all marine mammal sightings (except humpback whale)

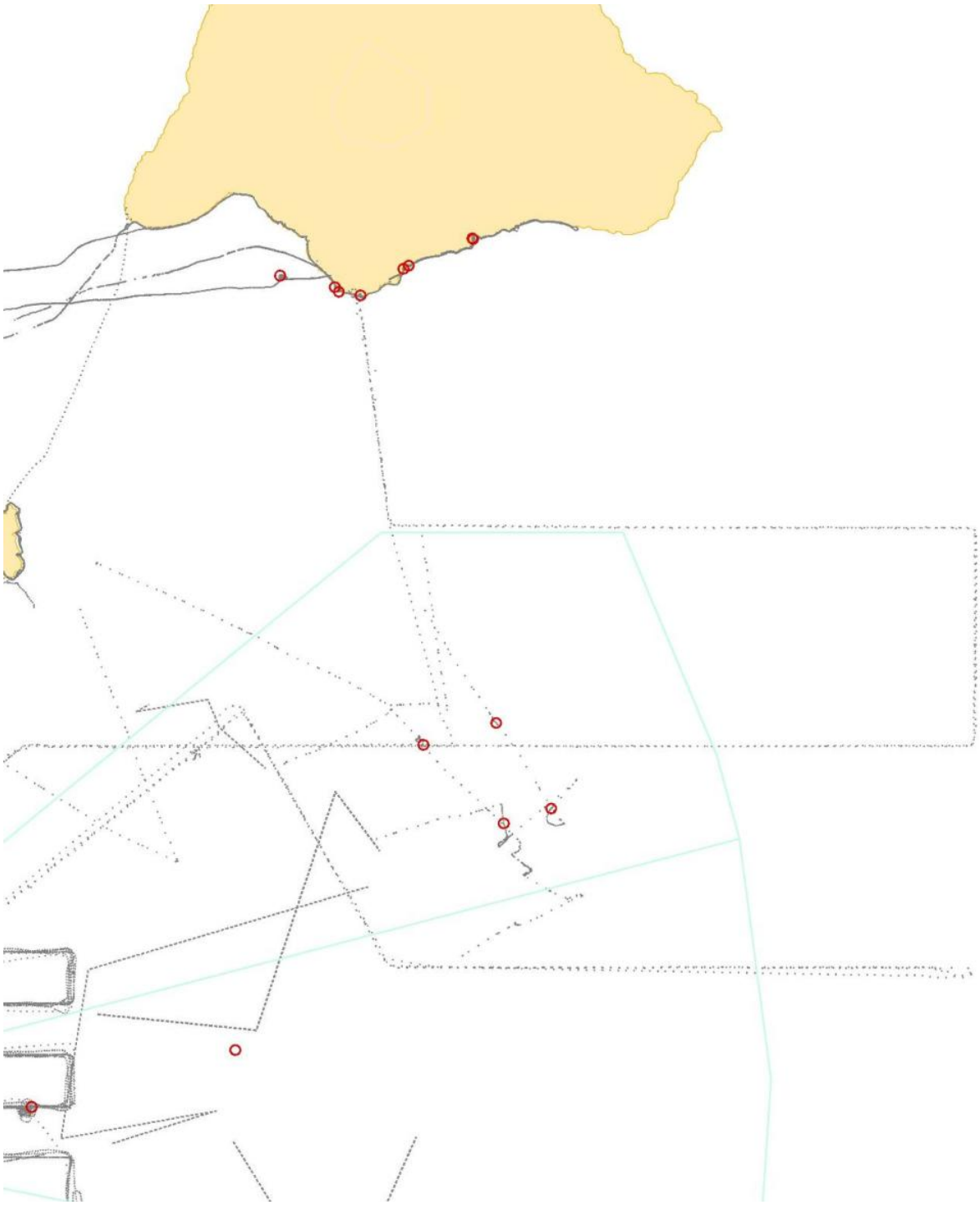

Figure 4. Detail west of Big Island: All survey tracks and all marine mammal sightings (except humpback whale)

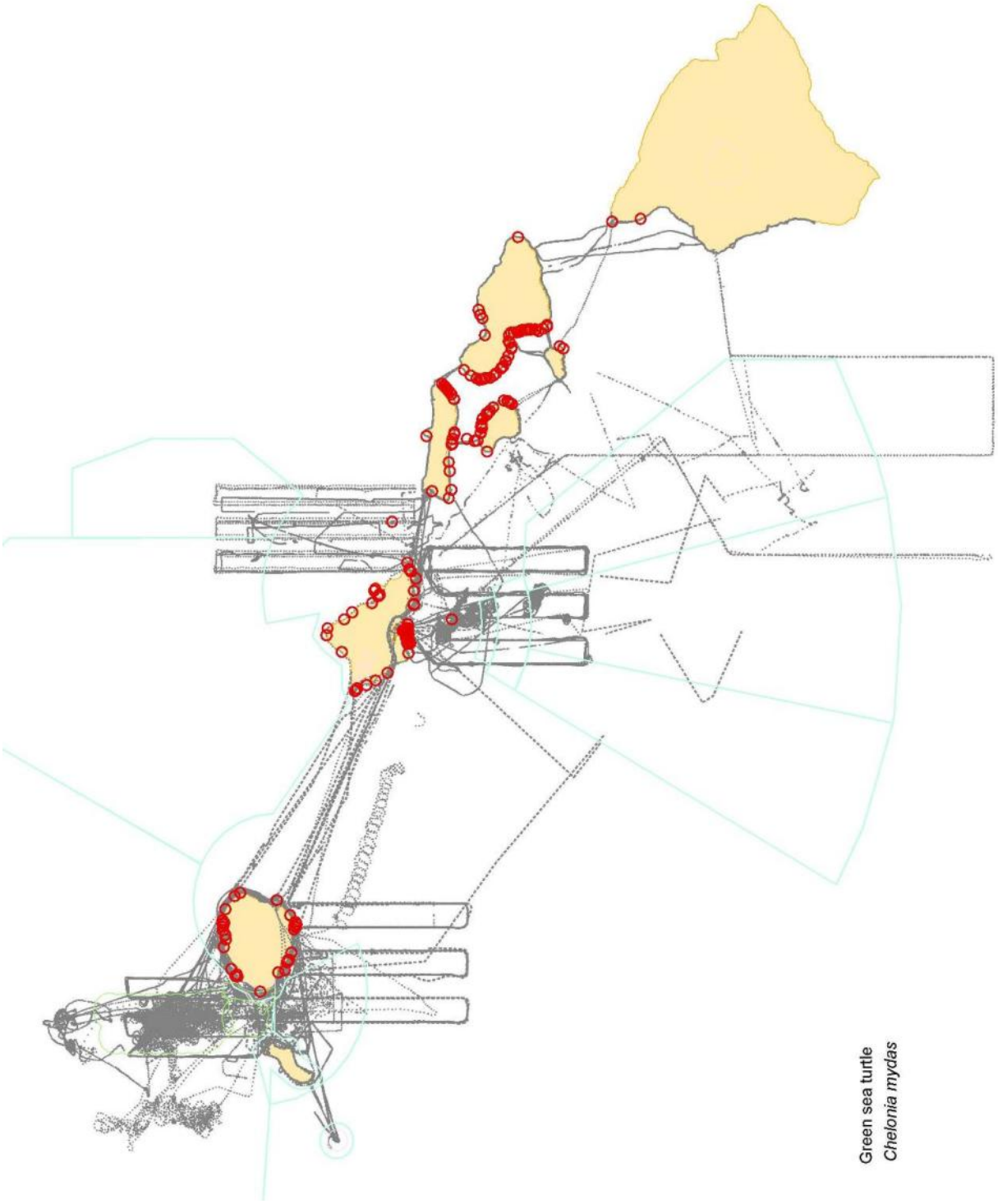

Figure 5. Green sea turtle (Chelonia mydas)

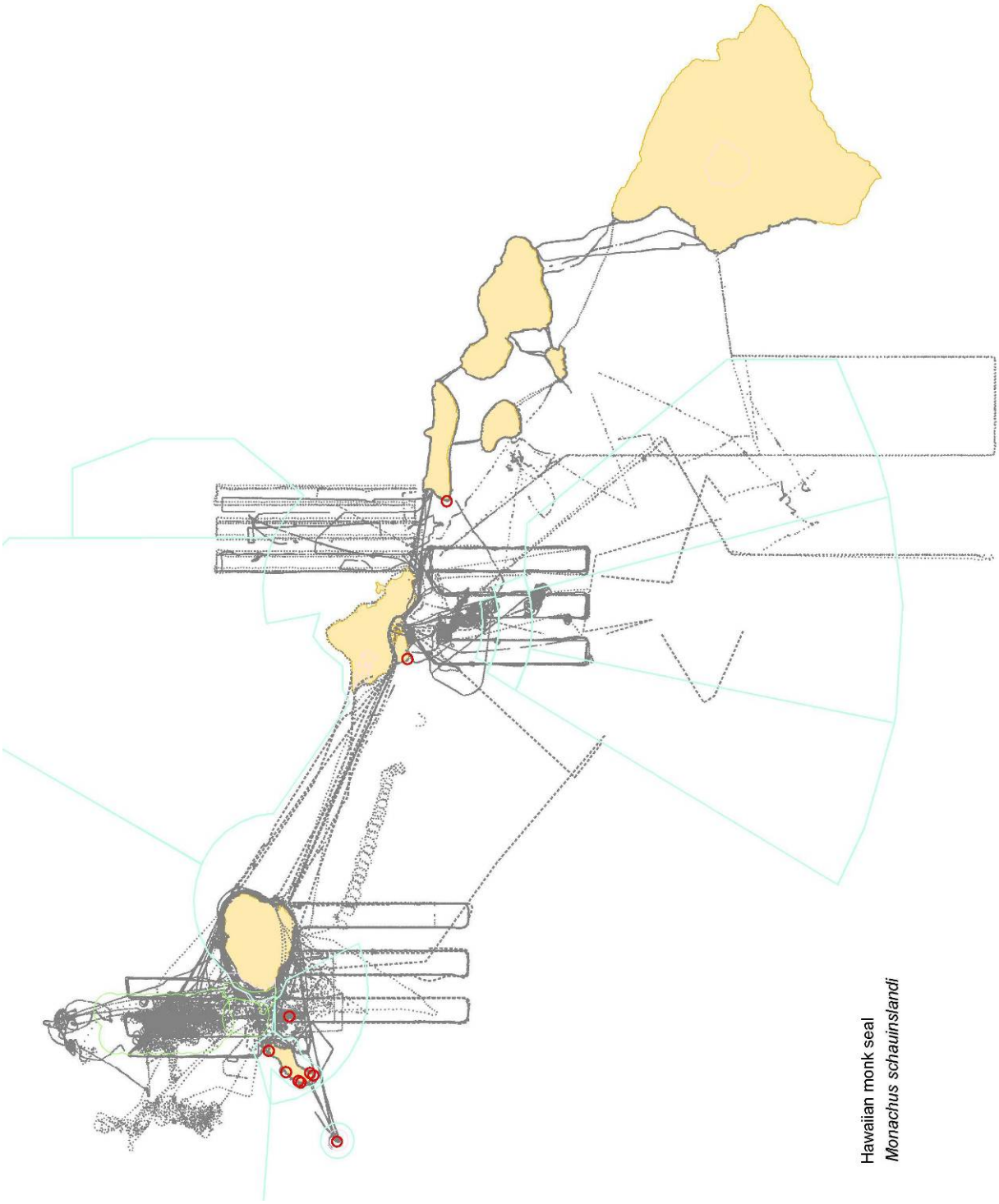

Figure 6. Hawaiian monk seal (Monachus schauinslandi).

Note: All sightings were of hauled-out animals on the shore, except for one sighting of a swimming animal in the channel between Kauai and Niihau.

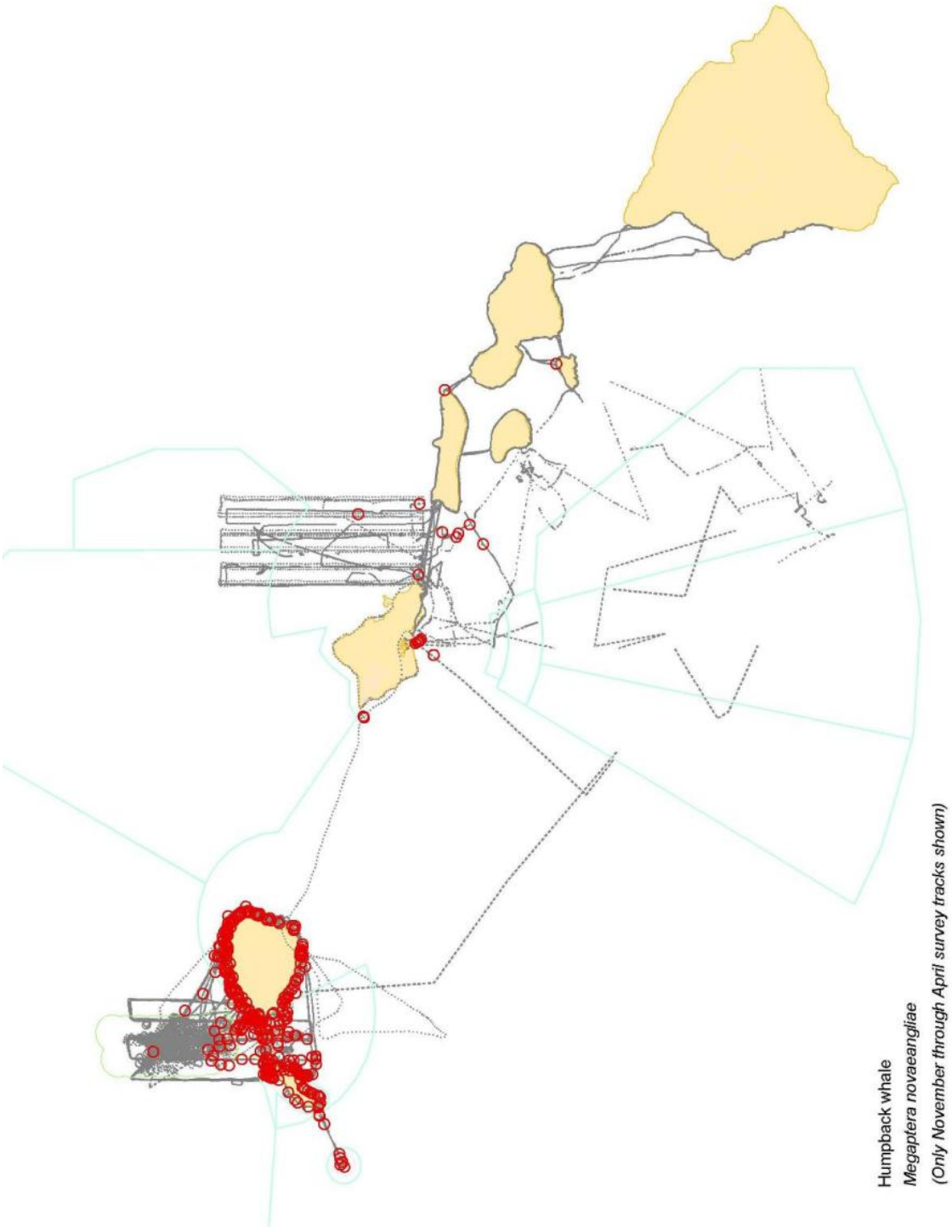

Figure 7. Humpback whale (Balaenoptera novaeangliae).

Note: Only November through April survey tracks shown; see section 2.1.1 for a list of surveys represented in this figure.

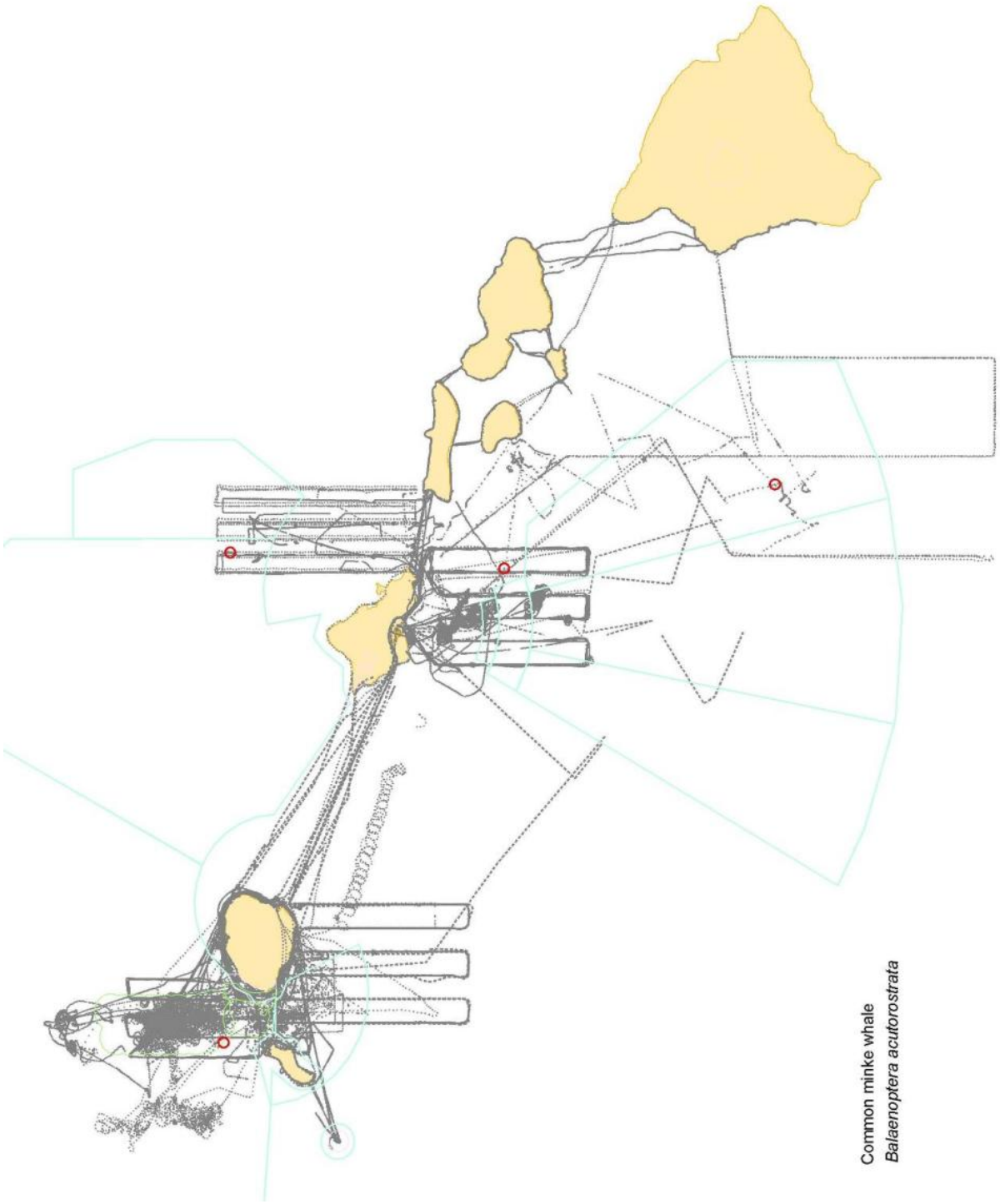

Figure 8. Common minke whale (Balaenoptera acutorostrata).

Note: Sightings represent observations labeled as minke whale, as well as those labeled "unidentified small whale" or "probable minke whale."

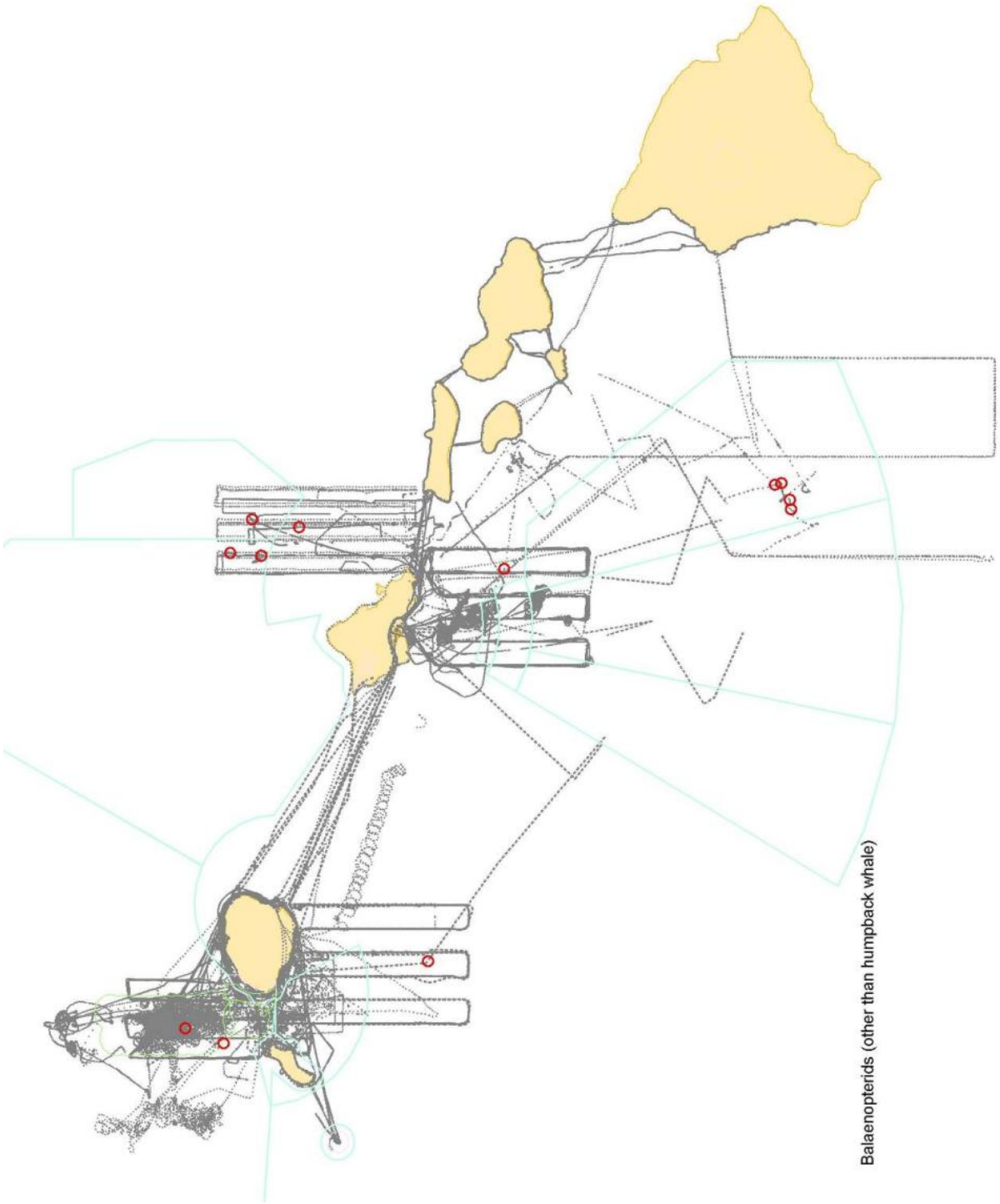

Figure 9. Balaenopterids other than humpback whale.

Note: Sightings represent those labeled as "unidentified large whale" outside of the winter humpback season, those labeled as "unidentified non-humpback balaenopterid" during the season, as well as sightings labeled as sei whale *(Balaenoptera borealis)*, Bryde's whale (*Balaenoptera edeni*) and minke whale (*Balaenoptera acutorostrata*). No fin whales (*Balaenoptera physalis*) were positively identified in the included surveys.

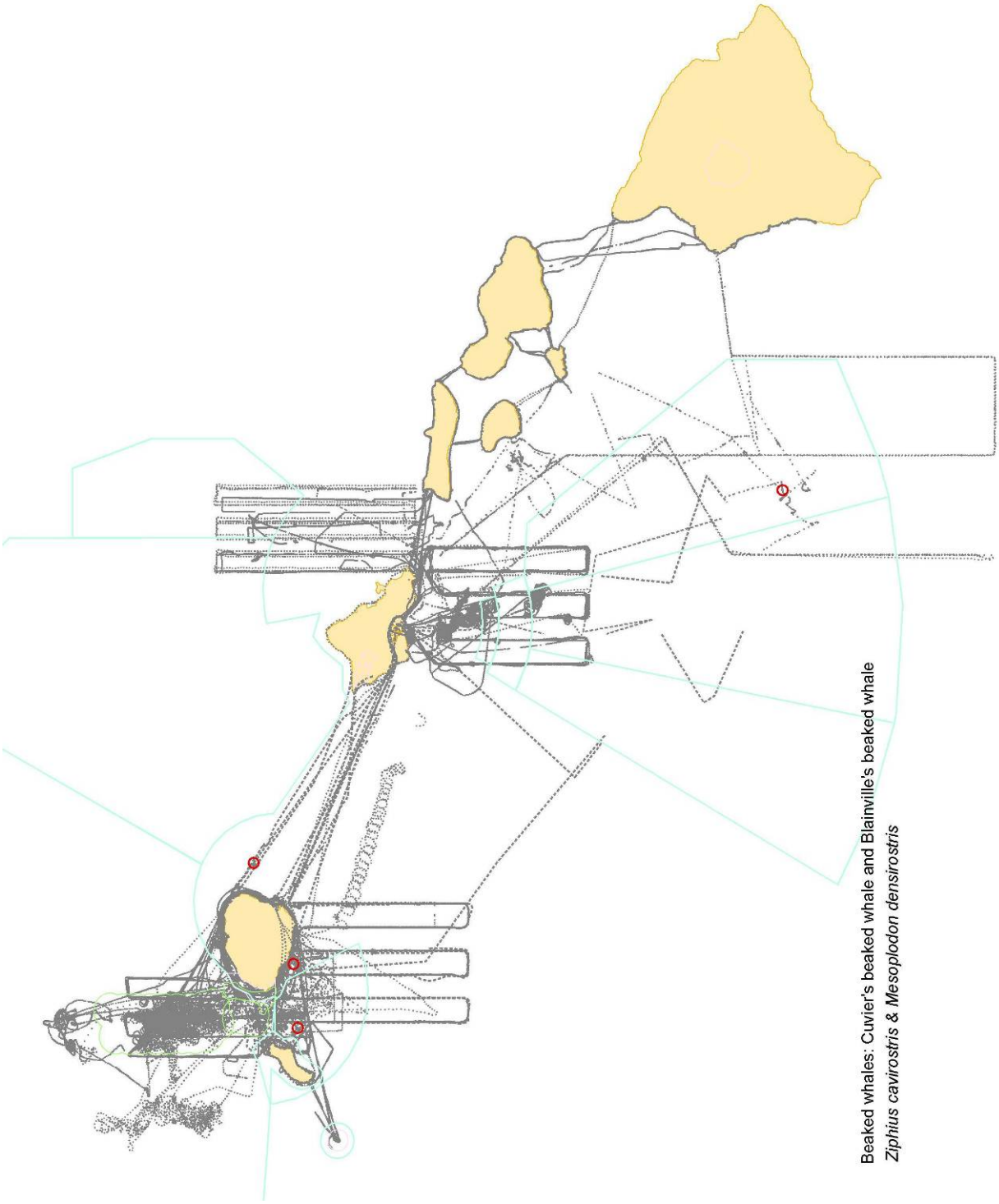

Figure 10. Beaked whales: Cuvier's beaked whale (Ziphius cavirostris) *and Blainville's beaked whale* (Mesoplodon densirostris).

Note: One sighting was "unidentified Mesoplodon." No sightings of Longman's beaked whale (*Indopacetus pacificus*) were made in the included surveys.

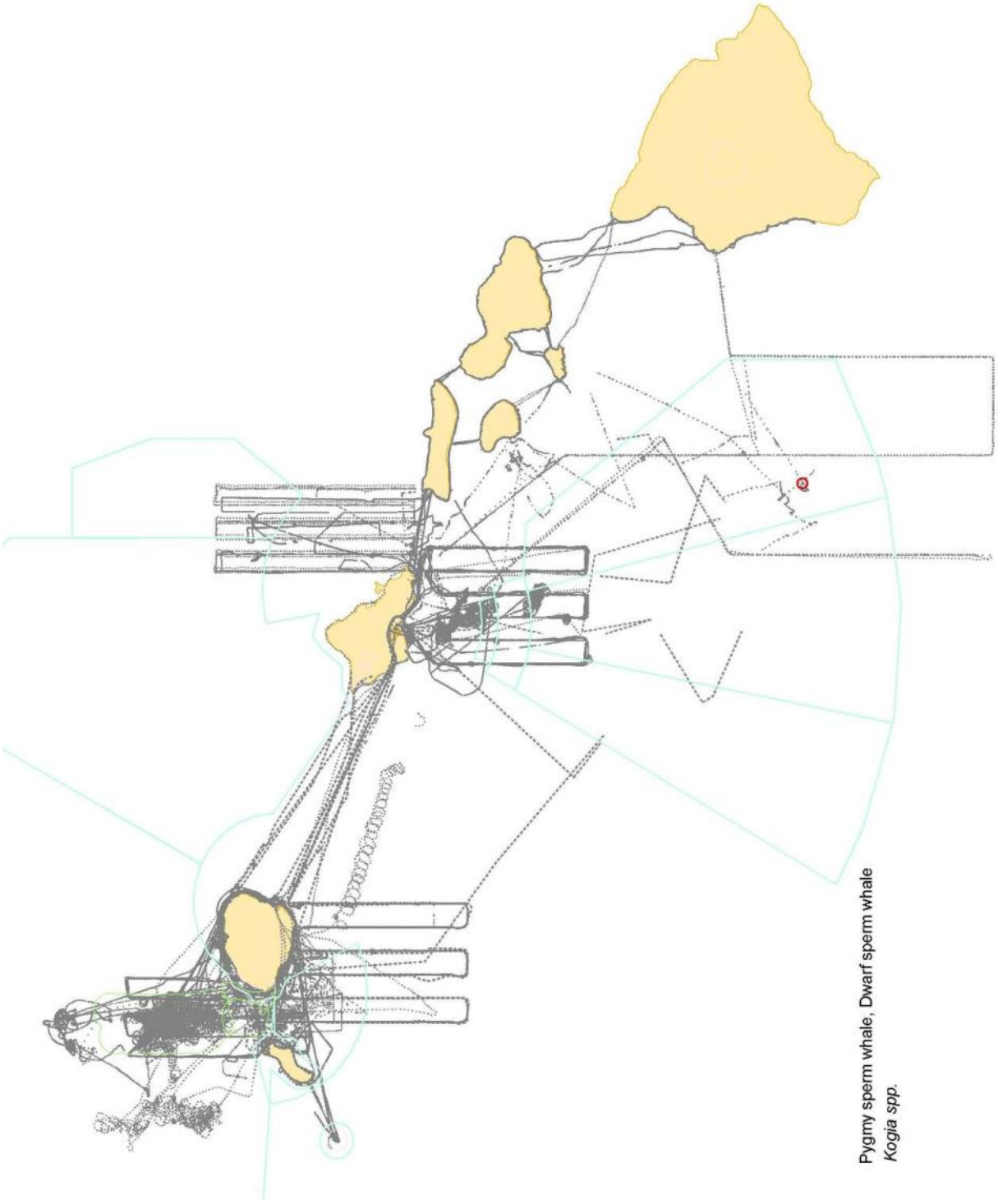

*Figure 11: Pygmy and Dwarf sperm whale (*Kogia *spp.)*

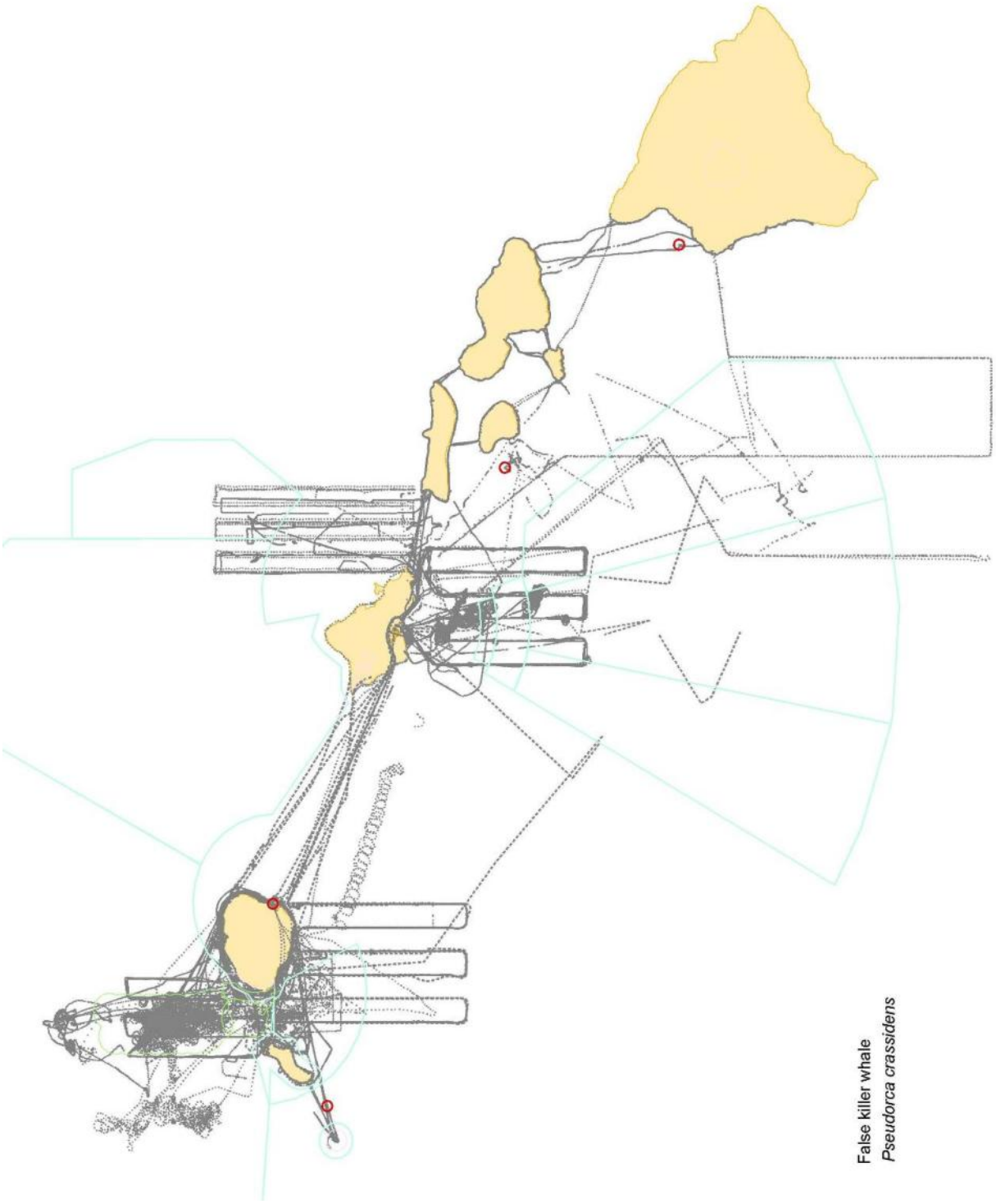

Figure 12: False killer whale (Psuedorca crassidens).

Note: the sightings do not differentiate between population stock, although the sighting at Ka‘ula islet (the sighting farthest west) was confirmed to not be composed of known members of the Hawaii Insular stock.

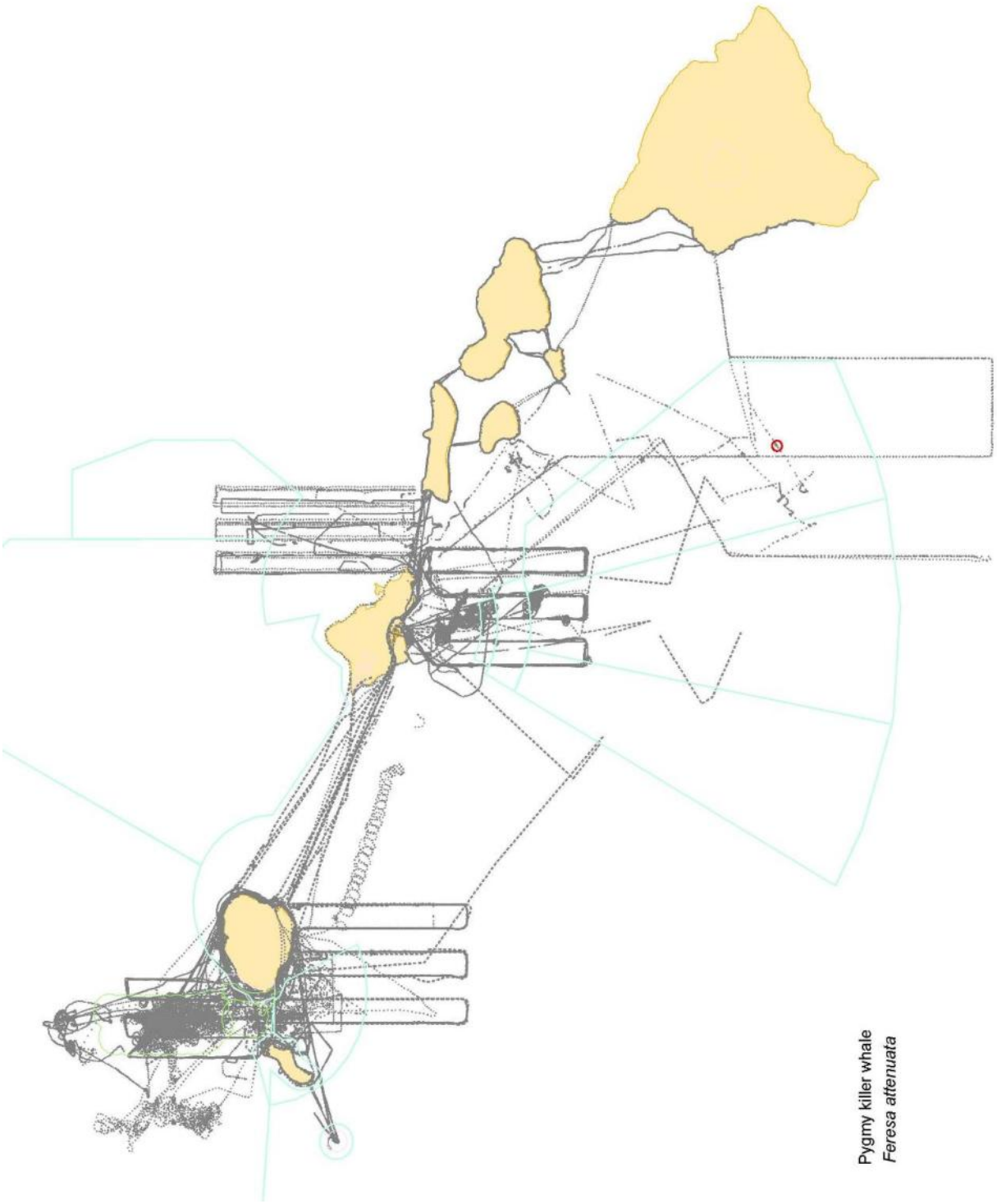

Figure 13: Pygmy killer whale (Feresa attenuata)

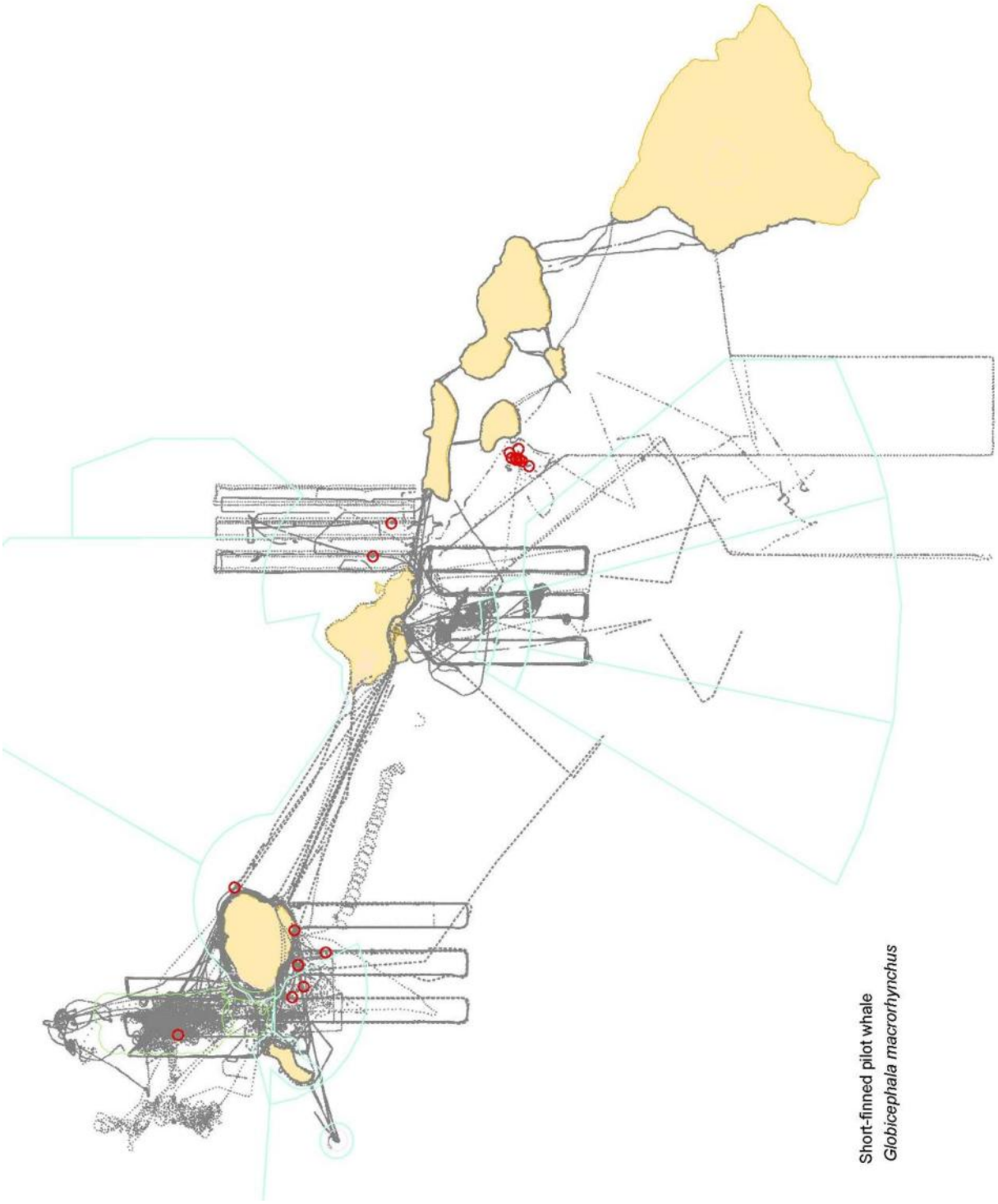

Figure 14: Short-finned pilot whale (Globicephala macrorhynchus)

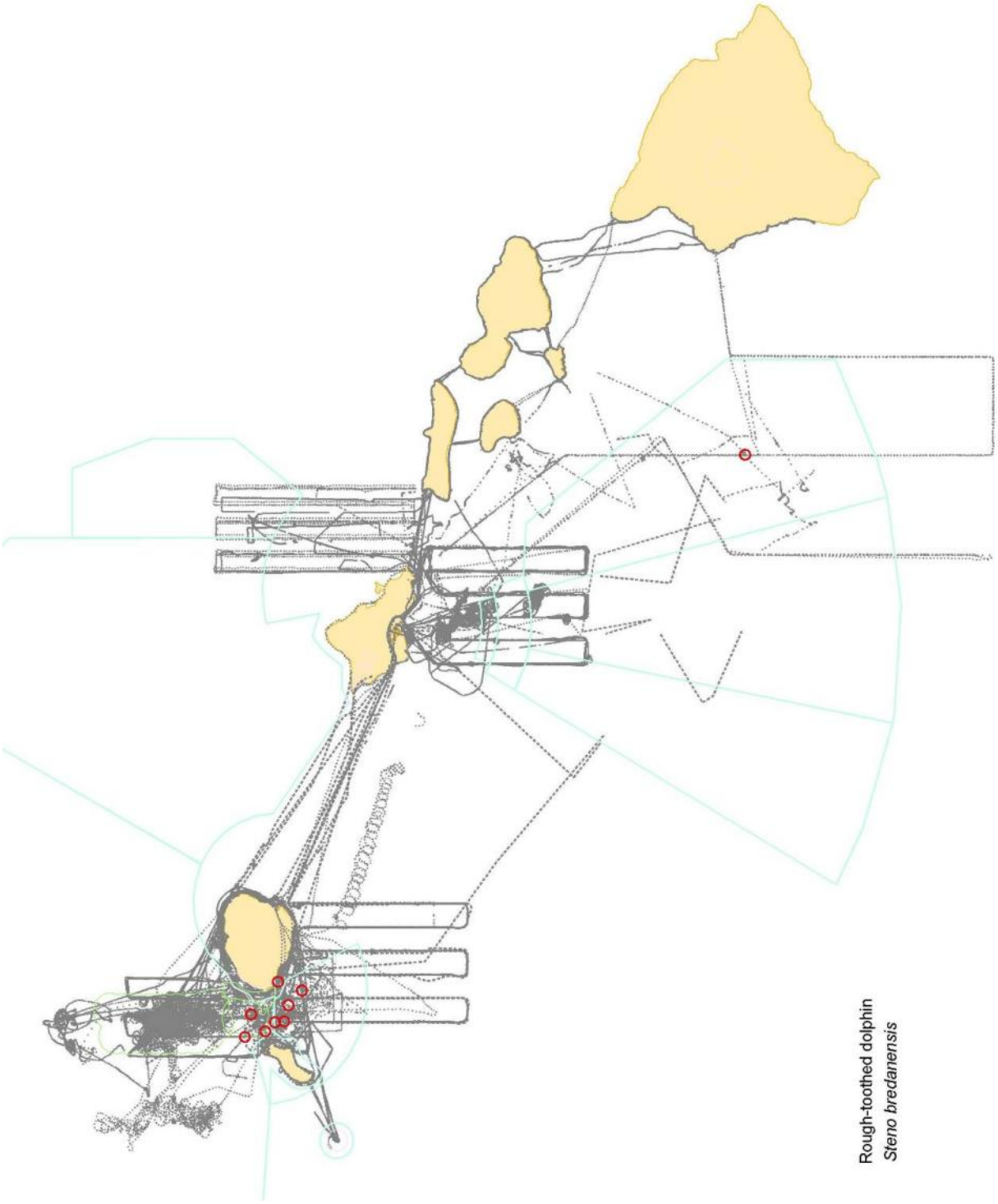

Figure 15: Rough-toothed dolphin (Steno bredanensis)

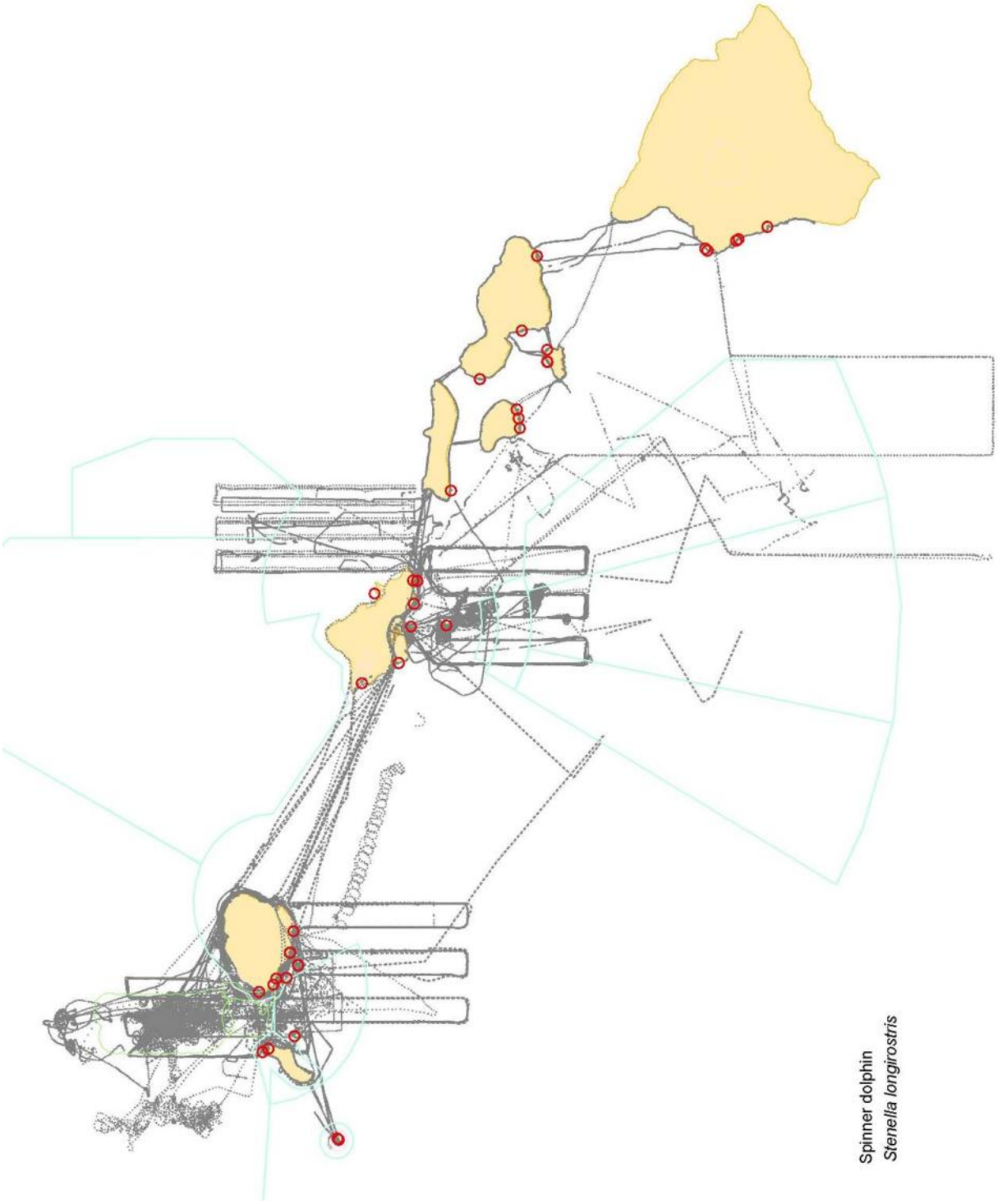

Figure 16. Spinner dolphin (Stenella longirostris)

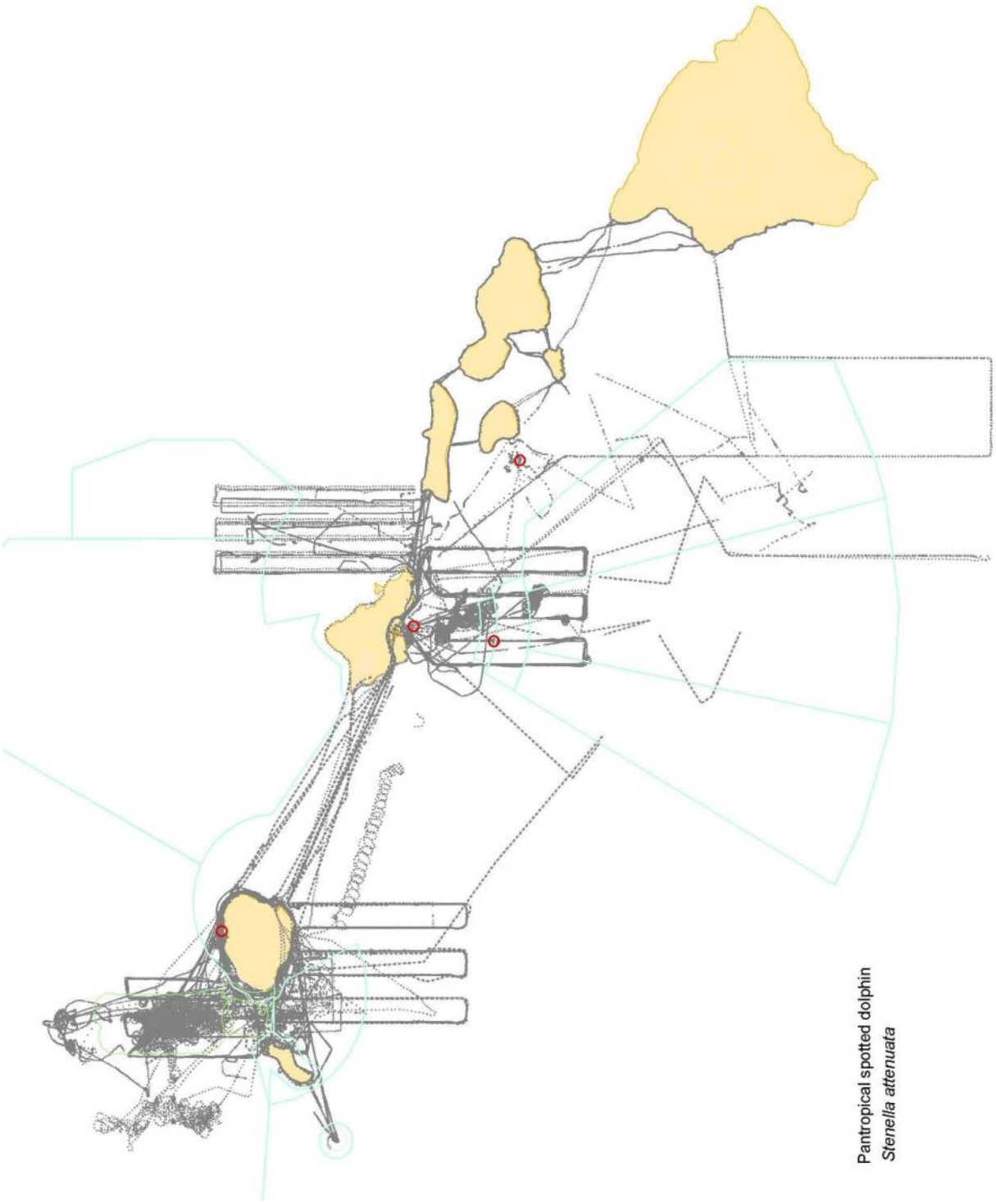

Figure 17. Pantropical spotted dolphin (Stenella attenuata)

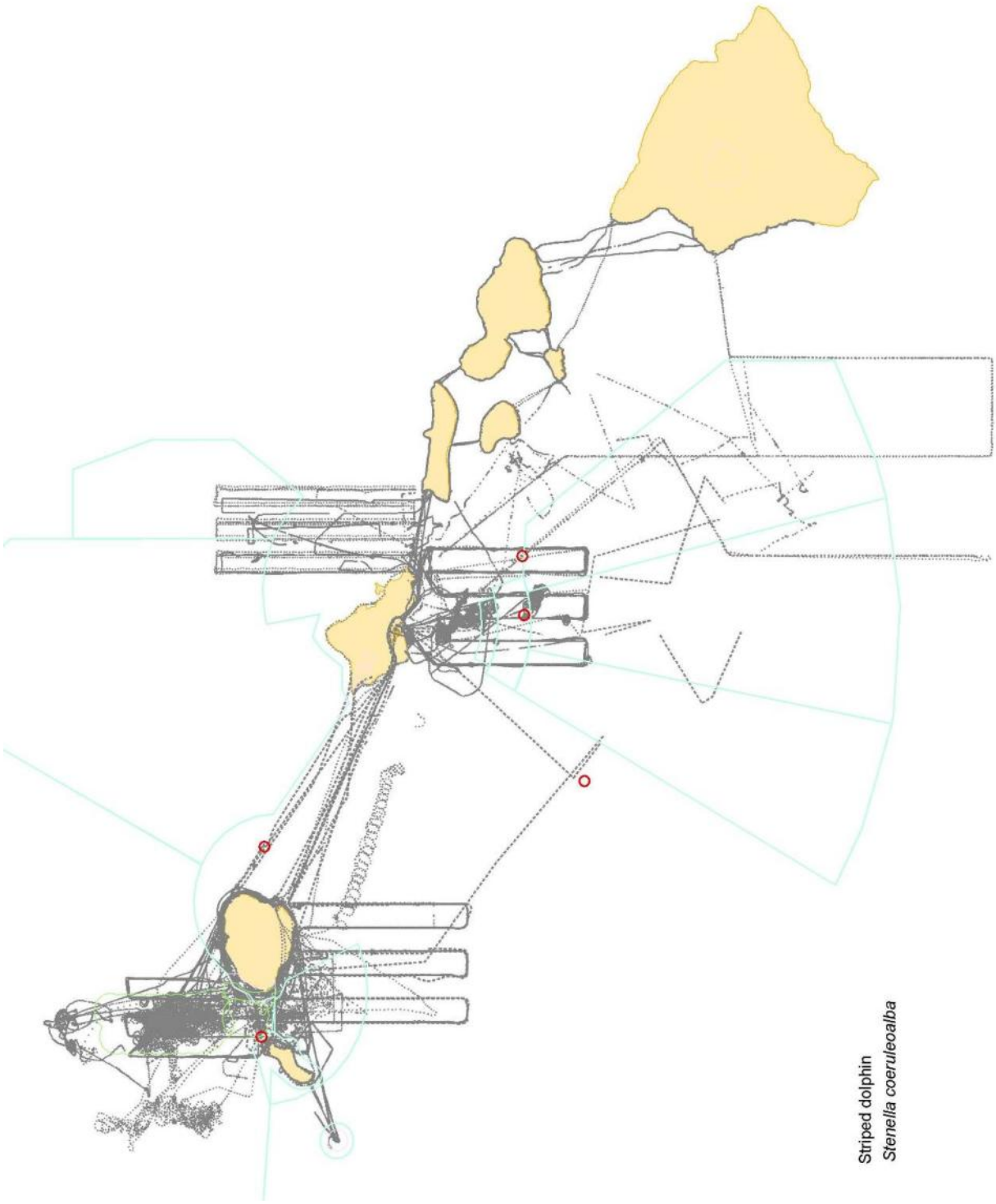

Figure 18. Striped dolphin (Stenella coeruleoalba)

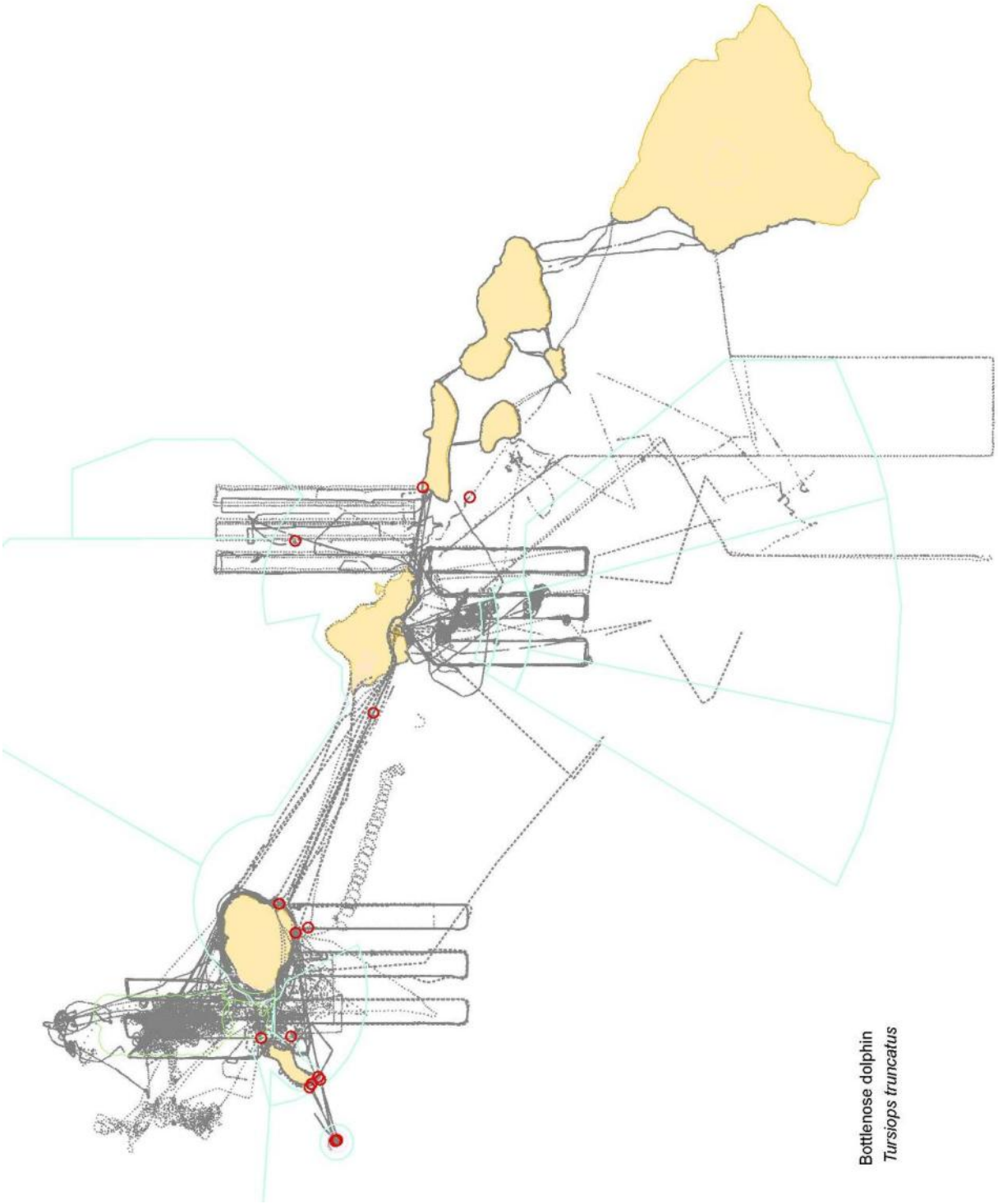

Figure 19. Bottlenose dolphin (Tursiops truncatus)

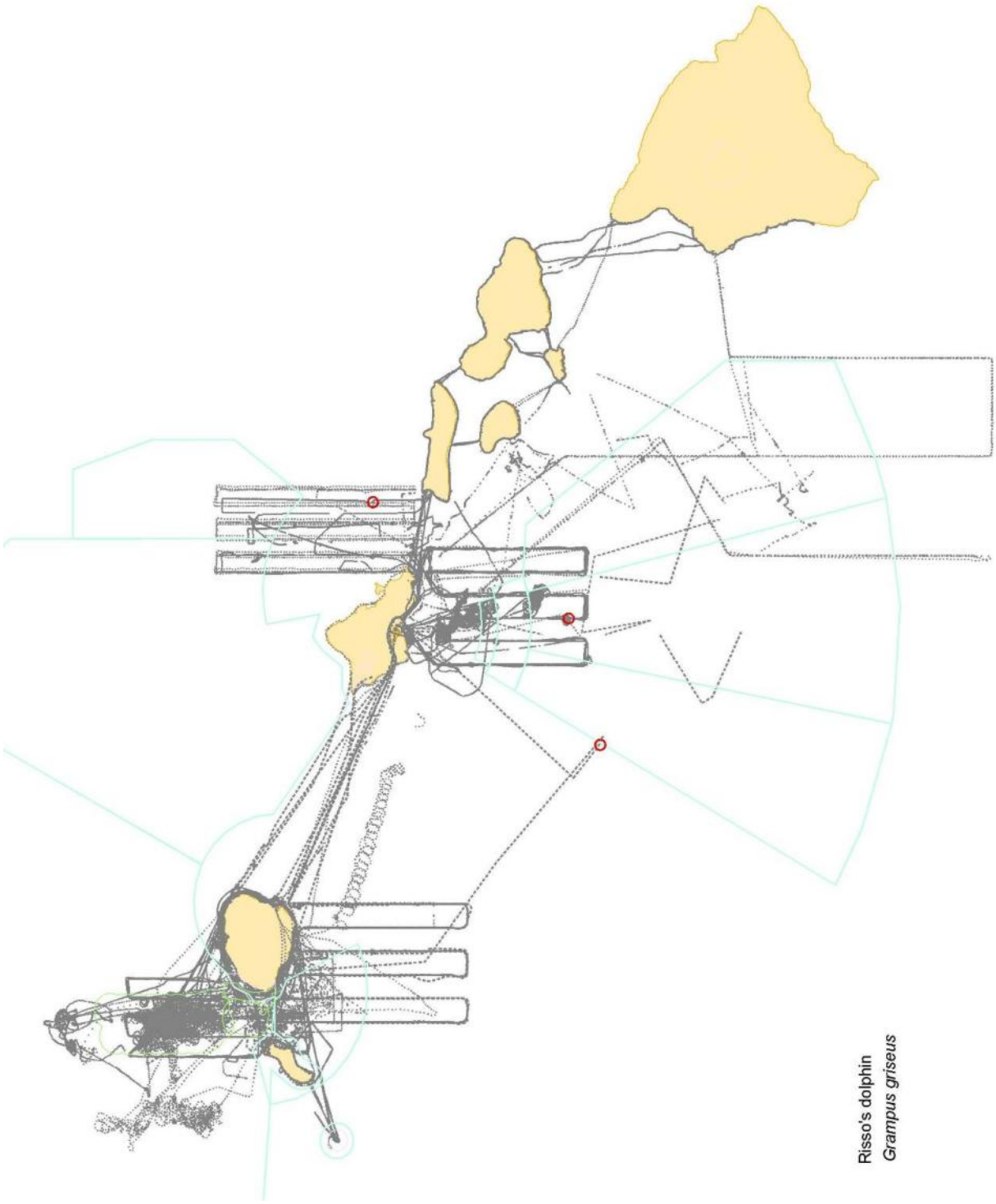

Figure 20. Risso's dolphin (Grampus griseus)

4. DISCUSSION

4.1 Preliminary Conclusions

This report represents the initial phase of integrating results over the entire course of all visual surveys conducted for the Commander, U.S. Pacific Fleet's marine species monitoring program. A primary goal is to use the results from the integration of data to help inform future management decisions.

Frequency of sighting: Although power analyses were not performed in association with this data compilation, it appears that developing density estimates for most species would require large levels of effort, potentially at multiple times greater than the total completed so far. In particular, some species were sighted only once across all survey efforts (e.g., *Feresa attenuata, Kogia spp.*), beaked whales were sighted only three times across two species (*Ziphius cavirostris and Mesoplodon densirostris)*, whereas other species were not sighted at all (e.g., *Physeter macrocephalus, Peponocephala electra, Indopacetus pacificus, Balaenoptera physalus, Eretmochelys imbricata*).

Species that may be more amenable to some shorter-term density analyses include the green sea turtle (*Chelonia mydas)*, spinner dolphin (*Stenella longirostris)*, and the humpback whale (*Megaptera novaeangliae)*. Also in certain coverage areas, species that may be amenable to shorter-term density analyses include the rough-toothed dolphin (*Steno bredanensis)* in the channel between Kauai and Niihau, and the short-finned pilot whale (*Globicephala macrorhynchus)* to the southeast of Kauai and Lanai.

Shore and offshore: Notable offshore observations of species that are typically seen either nearshore or onshore include two offshore sightings of green sea turtles, and one offshore sighting of a Hawaiian monk seal (*Monachus schauinslandi)* (Figs. 5, 6). With regard to shoreline surveys, this methodology (both aerial- and vessel-based) has enabled the study of hauled-out monk seals at Niihau and Kaʻula, although it is notable that relatively few animals were sighted on other islands: one each on Oahu and Molokai, and no animals sighted hauled out on Kauai, Maui, Lanai, Kahoolawe, and the Big Island (Fig. 6). It is unknown whether this observational pattern is due to actual relative distribution of animals, or the interaction of artifactual variables such as relatively greater observer attentiveness on smaller islands, type or color of terrain, relative time of day of flights, or observational platform (i.e., vessel or aerial). In contrast Green sea turtles have not been sighted at Niihau or Kaʻula, but have been sighted frequently on all other islands except for the Big Island, where a few sightings have been made on the northern end of the west coast (Fig. 5). Also notable is that the aerial surveys during events and shoreline surveys, which are conducted before, during and after Navy training events using MFAS, have in total detected no marine mammals demonstrating unusual behavior, stranded, or in distress.

Areas of interest: Areas that have been frequently surveyed, but with relatively low numbers of sightings include to the south of Kauai, north of the channel between Oahu and Molokai, and the majority of the northern half of the instrumented underwater ranges at PMRF. The waters offshore of PMRF between Kauai and Niihau have been heavily surveyed and have yielded a moderately high number of sightings. Areas that have not been surveyed that are within or adjacent to potential exercise areas include waters adjacent to the underwater range at PMRF, including to the north of Niihau toward Middle Bank, to the south of Niihau, and to the north of

Kauai. Other areas that have not been surveyed include to the north of Oahu, north of Oahu, and the offshore waters which are both south of the four-island region and west of the Big Island. Areas that have been infrequently surveyed, but that have still yielded relatively higher numbers of sightings include waters offshore the leeward side of Lanai and the seamount chain west of and in the lee of the Big Island (e.g., Jaggar and Perret seamounts).

Types of surveys: The included survey protocols have included line transect, transits to areas of monitoring interest, shoreline surveys, and follows of or embarks upon Navy assets. Relatively under-represented are opportunistic surveys that follow coverage of estimated marine mammal habitat such as depth isobaths, while at the same time seeking ideal sightings conditions in calmer weather typically found on the leeward sides of each island. Also, no shore-based surveys utilizing a theodolite to fix sighting positions are represented in the list of included surveys.

4.2 Future directions

After the initial summary of survey effort and sightings contained in the present report, future goals of the data integration task for visual surveys in the HRC include:

1. Continuing to collect data from upcoming field efforts

2. Collecting archival data from past efforts where trackline raw data was not originally delivered by the contractor, or is not otherwise immediately available or yet delivered:

    a. The five surveys listed in section 2.2.1 for which electronic deliverables of the survey track and sightings were not available, and the UNDET survey listed at the 2.2.2.
    b. 2011 Feb 16-March 5 SCC and USWEX aerial surveys (HDR, Contract #N62470-10-D-3011 CTO KB07): electronic deliverables currently pending
    c. 2011 July M3R tagging survey (HDR/CRC #N62470-10-D-3011 CTO KB07, partially funded by N45)

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